SKB EP®

DIAGNOSTICS INSTRUMENTS
FOR HIGH-VOLTAGE EQUIPMENT

CATALOGUE

WWW.SKBPRIBOR.COM

COMPANY

SKB EP, LLC (ISO 9001:2008) is an innovative total cycle enterprise with more than 26-year successful history. Having started its activity in 1992 as a small subdivision of the Energy Systems Institute of the Siberian Branch of the Russian Academy of Sciences, today SKB EP has more than 13,000 customers in the Russia, Vietnam, Latvia, Lithuania, Moldova, Uzbekistan, Kyrgyzstan, Belarus, and Kazakhstan.

We specialize in development and production of diagnostics and control instruments for high-voltage circuit breakers and transformers produced in Russia and other countries (ABB, Areva, Siemens, Alstom, etc.).

13,000	30	26	13	16	2
CUSTOMERS	MODELS OF INSTRUMENTS	YEARS IN THE MARKET	PLANTS PRODUCING HIGH-VOLTAGE EQUIPMENT*	DEALERS	PATENTS

* 13 plants producing high-voltage equipment use the instruments in the Quality Control Department.

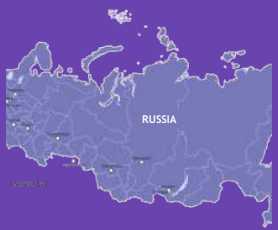
All instruments have the following certificates: Safety Test Certificate IEC 61010-1:2001, EMC Compatibility IEC 61326-1:2005, Kussian Register of Innovative Products6 Register Innovative Solutions by ROSSETI PJSC, Recommended for use in JSC Russian Railways electric installations, Safety certificate and Registration in the State Register of the Russian and Former Soviet Union countries.

The quality and innovation of the instruments are confirmed by the Award for Technical Superiority of the products rewarded by IDGC Holding (JSC Rosseti), patents and Customers' feedbacks.

The instruments are successfully used in combined heat and power plants, hydroelectric plants, nuclear power stations, railways, oil- and gas processing plants of Russia, Vietnam, Latvia, Lithuania, Moldova, Uzbekistan, Kyrgyzstan, Belarus, and Kazakhstan.

The calibration laboratory of SKB EP is certified by the Federal Calibration System of Russia (ISO 17025-2009) under № RA.RU.312297 for technical competence in instruments calibration measuring. All manufactured products undergo obligatory tests.

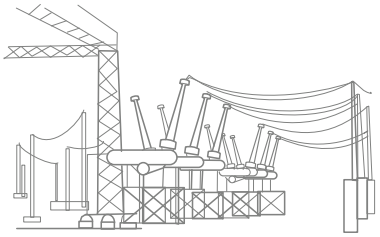
The unique method, which may expose incipient defects in circuit breakers at early stage. This 1.5 times increases the high-voltage equipment service life and decreases repair costs by 30%.



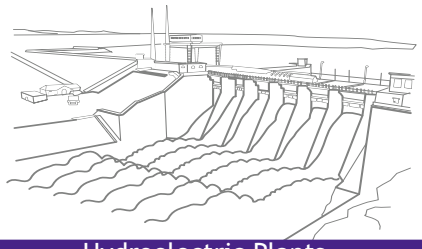
The company has reach experience in development and production of instruments for high-voltage equipment diagnostics and control. At the same stage we are very active in developing a dealer network and is looking for new partners.

TABLE OF CONTENTS

AREAS OF APPLICATION AND FUNCTIONS OF THE SKB EP INSTRUMENTS

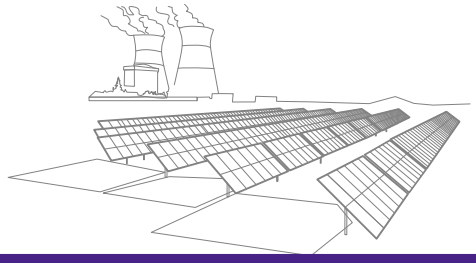


Hight-voltage substations

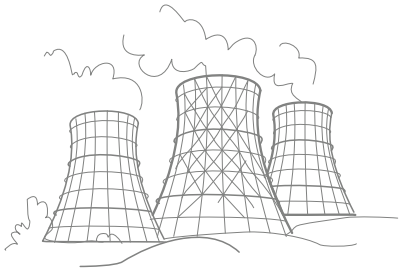


Hydroelectric Plants,
Pumped-storage Hydro Station

Wind mills



Solar power plants



Combined Heat and Power Plants,
Hydro Electric Power Plants, Nuclear Power Stations

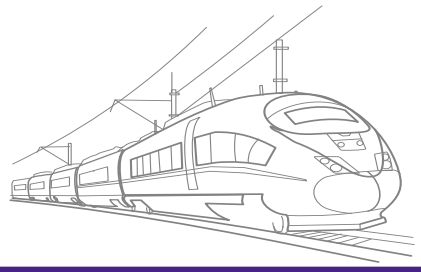
DIAGNOSED FACILITIES

Switchgears 6/10/35/110/220/330/500 kV (Switchgears, Complete switchgears, Closed switchgears)

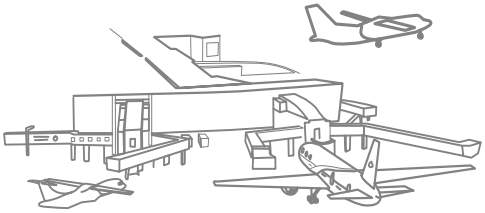
Current and voltage measurement transformers

High-voltage circuit breakers (oil, vacuum, SF6 and air-blast circuit breakers)

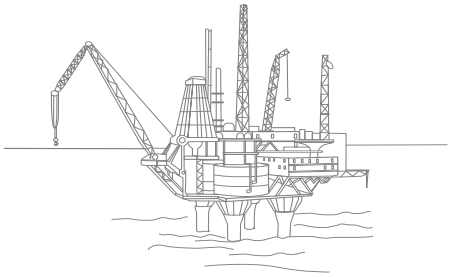
Power transformers and autotransformers



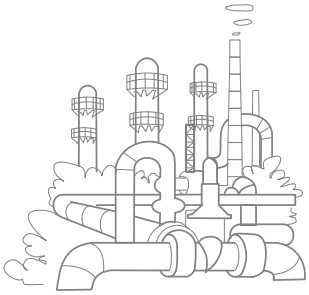
Rail facilities



Airports



Oil platforms



Oil- and gas- processing plants

Manufacturing facilities

OLTC (On-load tap changers)

Complete transformer substations

Cable lines

Electric machinery, motors, generators, and synchronous capacitors

Rail joints and wheel sets


СКБ ЭП
ПРИБОР КОНТРОЛЯ ВЫСОКОВОЛЬТНЫХ ВЫКЛЮЧАТЕЛЕЙ ПКВ/УЗ

PKV GROUP: DIAGNOSTICS INSTRUMENTS FOR HIGH-VOLTAGE CIRCUIT BREAKERS

Instruments for measuring the time, travel and speed characteristics of the high-voltage circuit breakers' main contacts as well as voltage and amperage of electric magnets, magnet coils, and their drives.

PKV/U3.1

PKV/U3.0

PKV/M17

Different methods are used for assessing the state of HV circuit breakers.

Special instruments PKV/U3 and PKV/M17 considerably facilitates andaccelerates the diagnostics.

When selecting the instrument, one should pay attention to certain peculiar features, e.g., time characteristics are easy to record for any type of high-voltage circuit breakers, whereas travel and speed characteristics require special linear or angular displacement transducers. Note that PKV analyzers are completed with them. The transducers are very precise, easy to operate and do not require tuning.

Owing to transducers the PKV analyzers can register time intervals, speed and travel characteristics, and make graphs of speed vs time and travel; currents and voltages of electric magnets vs time and travel; as well as diagrams of contacts closing/opening.

The SKB EP specialists have developed their own method for high-voltage circuit breakers diagnosis. Systems analysis of graphs generated during diagnosis using the PKV analyzers allows to evaluate high-voltage equipment technical condition. This analysis is referred to as "Method of the defects early detection in HV circuit breaker mechanisms".

This method allows early detection of defects, thus avoiding unnecessary (and often harmful) disassembly of properly operating nodes. Moreover, even minor experience in graphs interpretation allows efficient planning of maintenances, thus saving time and money of a company.

CERTIFICATES

- Safety Test Certificate IEC 61010-1:2001
- Russian Register of Innovative Products
- Russian State Register Certificates
- EMC Compatibility IEC 61326-1:2005
- Declaration of Conformity of the Customs Union

DIAGNOSTICS INSTRUMENT FOR HIGH-VOLTAGE CIRCUIT BREAKERS
PKV/U3

PKV/U3 is represented in two modifications: PKV/U3.1 and PKV/U3.0

Maintenance check of oil, vacuum, sulfur-hexafluoride (SF6) and air-blast circuit breakers for all voltage classes from 10kV to 1,050kV

Maintenance check of circuit breakers switches of Soviet, Russian and foreign manufacture (ABB, AREVA, ALSTOM, SIEMENS, etc.)

SPECIFICATIONS

SPECIFICATIONS	VALUE	
	PKV/U3.1	PKV/U3.0
Number of movement transducers in the set, pcs.	2	
Number of movement transducer channels, pcs.	1	3
Number of variable-resistance transducer channels, pcs.	2	12
Number of discrete channels for circuit breaker contacts monitoring, pcs.	20	
Range of measurement and recording of time intervals, sec	0.0004 ÷ 8	
Intrinsic error of time interval measurement, ms	±[0.1 + 0,0001*Tx], where Tx - measured time interval	
Range of linear movements measurement by DP12 transducer, mm	1 ÷ 900	
Intrinsic error of linear movements measurement by DP12 transducer, mm	±1	
Range of angular movements measurement by DP21 transducer, degree	0.09 ÷ 360	
Intrinsic error of angular movements measurement by DP21 transducer, degree	±[0.2 + 0,001*a], where a - measured movement	
Range of moving speed measurement by DP12 transducer, m/sec	0.02 ÷ 20	
Intrinsic relative error of speed measurement by DP12 transducer, %	±2	
Power switch cycles	Open; Close; Open - Pause - Close; Close - Delay for Open - Open; Open - Pause - Close - Delay for Open - Open	
Maximum commutated current, A	35	
Resistance measuring range for "Input 1" and "Input2" channels, Ohm	0 ÷ 2,400 Ohm (output current of 4 mA); 0 ÷ 160 Ohm (output current of 60 mA)	
Maximum consumed power, W	60	
Operation temperature range, °C	-15 ÷ +40	
Maximum measuring unit weight, kg	10	
Dimensions, mm	300x140x400	
IP rating in operating state	IP20	
Warranty	36 months	
Interface language / User manuals language	English	
Calibration interval, year	3	

PKV/U3 is represented in two modifications: PKV/U3.1 and PKV/U3.0

	PKV/U3.1	PKV/U3.0
Number of variable-resistance transducer channels	2	12
Number of movement transducers in the standard set	DP21 (1pcs.) and DP12 (1pcs.)	DP21 (3pcs.) and/or DP12 (3pcs.)
Number of movement transducer channels	1	3*
Circuit breakers subject to verification	all, except for VO-750, VO-1150, VNV-1150	all
Voltage classes of circuit breakers controlled	from 10kV to 500kV	from 10kV to 1,050kV
Simultaneous measuring of basic shaft turn angle and drive arm turn angle and pole	not available	available

PKV/U3 instrument is complete with attachment devices for the installation of measuring transducers on all types of Russian- and foreign-manufactured (ABB, AREVA, ALSTOM, SIEMENS) high-voltage circuit breakers.

Ranges of time intervals (up to 8.1 sec), speed (up to 20 m/sec) and travel (up to 900 mm) measurement sufficient for covering the needs for monitoring of existing circuit breakers.

*In order to get complete and objective information on a high-voltage circuit breaker state, travel and speed parameters should be taken by each of its poles. Standard complete set of PKV/U3.0 includes linear DP12 (1pcs.) and angular DP21 (1pcs.) movement transducers. In order to check parameters by three phases simultaneously one more group of DP12 (2 pcs.) and/or DP21 (2 pcs.) as well as the required tool kit with all necessary accessories is supplied on order.

One of the main items subject to diagnostics at air-blast circuit breakers' (VO-750, VO-1150, VNV-1150, VNV-500-40, VNV-500-65, etc.) operation monitoring is the measurement of nozzle actuator movement parameters (nozzle travel, movement start and end time, etc.). When drive movement changes, resistance of the rheostat changes as well and this change is recorded by PKV/U3.0 (In standard complete set cable for 10 variable-resistance transducers).

In order to view the results of diagnostics you need to connect the instrument to a portable personal computer (PC) with special software.

Along with the tables of digital parameters values more detailed information on the circuit breaker condition can be obtained. This info is collected from the following registered processes graphs: relation between speed and time, speed and travel; relation between electromagnet currents and voltages & time and travel; diagrams of contact opening-closing.

O-C-O

PKV/U3.0 is equipped with a power switch for control of switching device drive with solenoid current of up to 35A (direct and alternating) which allows performing both simple switching close or switching open operations and compound cycles "Open-Close", "Close-Open", "Open-Close-Open".

STANDARD COMPLETE SET:

- Instrument PKV/U3 and accompanying documents
- Software for computer
- Linear movement transducer DP12
- Angular movement transducer DP21
- Measuring stick
- Transducer cable
- Switch input voltage cable
- Local start cable
- Remote start cable
- A, B, C, D poles cables (4 pcs.)
- Pole cable (20 channels)
- Cable for 10 variable-resistance transducers (PKV/U3.0)
- Variable-resistance transducer cable
- Shunt voltage measuring cable
- Mains cable
- Ground wire
- LAN cable
- RS-232 cable
- VP2B-1V-2A cut-outs
- Cable end caps (8 pcs.)
- Attachment devices set kit
- Instrument carrying case
- Devices set For attachment of DP12 and DP21 transducers to various Russian-manufactured high-voltage circuit breakers

COMPLEX FOR CONTROL AND DIAGNOSTIC OF HIGH VOLTAGE CIRCUIT BREAKERS

PKV/M17

Enables to control circuit breakers of all types produced in Russia and abroad (SIEMENS, AREVA, ABB, ALSTOM, etc.)

Control is operated by 3 poles simultaneously up to 1 break per pole, or per 1 pole up to 6 breaks per pole

In-built micro ohmmeter for transient resistance measurement

SPECIFICATIONS

SPECIFICATIONS	VALUE
Quantity of circuit breaker channels, pc	6
Measurement range and registration of time intervals, sec	0.002 ÷ 20
Error time intervals measurements, us	$\pm 0.5*10^{-4}[1+tx]$, where t_x - measured time interval, s
Measurement range of linear travel by the DP12 sensor, mm	0.5 ÷ 900
Measurement error of linear travel by the DP12 sensor, mm	±0.5
Measurement range of angle travel by the DP21 sensor, degree	0.09 ÷ 360
Error of angle travel measuredt by the DP21 sensor, degree	±[0.2 + 0.001*a], where a - measured movement
Measurement range of speed by the DP12 sensor, m/sec	0.002 ÷ 50
Error of speed measurement by the DP12 sensor in a range	0.02 ÷ 10 м/с, % ±2
Cycles of the power switch	Open; Close; Open - Pause - Close; Close - Delay for Open - Open; Open - Pause - Close - Delay for Open - Open
Current measurement range by channels turn on and turn off, A	±35
Voltage measurement range by the Voltage input, V	±350
Resistance measurement range by the multipurpose input, Ohm	0 ÷ 250 Ohm (output current of 20 мА); 0 ÷ 2,500 Ohm (output current of 4 мА)
Measurement range of DC electrical resistance, Ohm	10^{-6} ÷ 0,1
Power of measured current, A	10
Types of data transmission channels	USB, USB host, LAN, Ethernet IEEE 802.3, Wi-Fi
Power consumption not exceeding, W	60
Operating temperature range, °C	-20 ÷ +50
Maximum measuring unit weight, kg	7
Dimensions, mm	360x290x165
Protection degree of the instrument in the operating position	IP20
Protection degree of the instrument in the transport position	IP64
Warranty	13 months

PKV/M17 can be completed with fastening devices for the installation of measuring sensors for any type of HV circuit breakers produced in Russia and abroad (ABB, AREVA, ALSTOM, SIEMENS и др.).

FIRST TRIP

For the first time among instruments produced in Russian we offer express analysis of a high-voltage circuit breaker condition by testing the first shutdown so called "FIRST TRIP". This function allows identifying emerging and critical failures of the drive and the contact system. This can be detected by measured characteristics of circuit breakers during the first switch off.

PKV/M17 enables to monitor the speed and travel parameters simultaneously by 3 poles (three travel sensors). It allows to control the time characteristics of high voltage circuit breakers, isolators and short-circuiting switches simultaneously at 3 poles up to 2 breaks per pole, or by 1 pole up to 6 breaks per pole.

Extended measuring range of time intervals (up to 20 sec), speed (up to 50 m/sec) and travel (up to 900 mm), covering the monitoring needs of most high voltage circuit breakers. Incremental (discrete) sensors DP12 and DP21 type are supplied together with PKV / M17. The sensors are aimed to measure speed and travel characteristics, require no adjustment of the conversion rate. In addition, the instrument supports a wide range of sensors: rheostat type, laser triangulation and digital incremental.

The software allows automatic calculations of an extended set of additional characteristics specific to a certain technical condition of the high voltage circuit breakers: parameters of time, travel and speed, both for the drive shaft and for contacts, time difference, the duration of the rattle, delay, rebound, flight, average speeds on different parts of the stroke and others.

Along with the tables of digital values of parameters more detailed information on circuit breaker condition can be obtained from the following registered graphs of processes:

- relation between speed and time, speed and travel;
- relation between electromagnet currents and voltages, and time and travel;
- diagrams of contact opening-closing.

According to the developed methodology, the emerging or existing defects of a high voltage circuit breaker (such as increase of the backlash, weakening of the spring, increased friction, failure of the damper, etc.) have characteristic features and peculiarities on the graphs by which it is possible to judge the state of its elements.

O-C-O

PKV/M17 power switch provides opportunity to control cycles of either simple (“Open”, “Close”) or compound (“Open-Close”, “Close-Open”, “CloseOpenClose-Open”, “CloseOpenClose-OpenClose”) type with maximum current of up to 35A for DC or AC drives with the required setting of the pulse durations of switching on and off, putting pauses and delaying off.

μΩ

In-built micro ohmmeter for transient resistance measurement of circuit breakers cables contacts of poles in range 1 ÷ 100 000 μΩ at current up to 10A.

PKV/M17 has a big (7 inch) colored graphic display of high brightness which makes it possible to easily read in sunny weather. Easy to understand interface with sensor screen makes it easy to use the instrument. Link with a personal computer is carried out via USB or LAN.

STANDARD COMPLETE SET:

The instrument is under development and testing.

Standard and additional setting are under confirmation.

Approximately period of production is 4th quarter of 2018.

MIKO GROUP: INSTRUMENTS FOR RESISTANCE MEASUREMENT

MIKO-10 | MIKO-21 | MIKO-2.3 | MIKO-7M MIKO-7MA | MIKO-8M MIKO-8MA | MIKO-9 MIKO-9A

MIKO group instruments are developed for electric resistance measurement:

Microohmmeters:

MIKO-10 is the latest, small-size, wrist-type microohmmeter for express measurement of electric resistance with the operating current of up to 10A.

MIKO-21 is an up-to date high-precision microohmmeter. Measurement error does not exceed ±0.05%. The range of measurement is 0.1 mkOhm ÷ 2 Ohm, test current is up to 200A. The instrument has a number of functions that considerably facilitate its operating, and measurement process in general.

Micromillikilloohmmeter:

MIKO-2.3 is a universal instrument for measuring the transient resistance of switching units using test current of up to 1000A, for measuring the windings resistance of low-capacity transformers, bypass, ballast and other resistors. The instrument allows to control all the above listed facilities with costs and weighs much less than a set of instruments needed for resistance measurement.

Milliohmmeters:

MIKO-7M(A), **МИКО-8М(А)** and **MIKO-9(A)** are used for measuring the active transformers windings resistance (including those with OLTC devices), electric magnets, cables and other.

CERTIFICATES

- Safety Test Certificate IEC 61010-1:2001
- EMC Compatibility IEC 61326-1:2005
- CE Conformity Certificate
- Russian Register of Innovative Products
- Recommended for use in JSC Russian Railways electric installations
- PJSC ROSSETI Register of Innovative Solutions
- Russian State Register Certificates
- Declaration of Conformity of the Customs Union

SMALL-SIZE MICROOHMMETER MIKO-10

Measurement of transient resistance in the range of 1 ÷ 100 000 μΩ, the error being as low as ±0.2%

Test amperage of up to 10A. Current runs continuously and for a sufficient period of time

The instrument can be placed on a wrist, fastened to a belt or hung on the neck

SPECIFICATIONS

SPECIFICATIONS	VALUE
Range of resistance measurements, μΩ	1 ÷ 100 000
Test amperage, A	1 ÷ 10
Limits of relative main error allowed, %	±0.2%
The number of measurements at maximum amperage and fully charged battery Energy independent memory, pcs, not more than	1000 100
Time of battery charging, hrs, not more than	3
Time of operating mode setting, sec., not more than	2
Time of one measurement	2 sec. - without CT from 2 to 30 sec. - with CT
PC interface	USB
Operating temperature range, °C	-20 ÷ +55
Weight of the test block, kg, not more than	0.5
Dimensions, mm	115x110x55
IP rating in operating state	IP54
Warranty	24 months
Interface language / User manuals language	English
Calibration period, year	2

Measurement of transient resistance in the range of 1 ÷ 100 000 μΩ:
- contacts of HV circuit breakers (including with built-in current transformers);
- contacts of automatic circuit breakers, interrupters, connecting devices, breakers, and relays;
- bolted, welded and brazing joints of wireways and buses.

The instrument is designed for being applied at electric networks, power plants and substations, traction substations of electric transport, and at industrial enterprises where 10A current is sufficient for measurements.

Three modes of measurements start-up have been implemented in the device:
- MODE 1: "Automatic start-up" - automatic start-up against the measurement circuit closing. It is used for identical multiple measurements of transient resistances, and for lots reject (e.g., of resistors).
- MODE 2: "Single start-up" - The measurement is started up by user's command. For measuring the resistance of any objects that allow connection of cable clamps first and then pressing the START button of the instrument.
- MODE 3: "An In-Built CT" means single measurement with account of a current transformer in the test circuit. For measuring the transient resistance of dead-tank circuit breakers with in-built current transformers. Test current amperage of 10A is set automatically.

The instrument incorporates a number of important functions:
- thermal EMF balancing in the test circuit;
- automatic disconnection of power supply if the instrument is not used;
- automatic start-up of measurements against the test loop integrity confirmation;
- automatic stop of measurements;
- beeping the measurements start-up and termination.

The instrument has an energy independent memory of up to 100 recordings, which is sufficient for overall and complex test of a transformer substation. USB connection to PC facilitates classification and recordings storage on the computer and measurement reports generation.

Its light weight (0.5 kg), small size (150x110x55mm) and an in-built accumulator allow us to refer it to a mobile independent instrument.

The instrument is placed into an ergonomic case that is fixed on the wrist by special belts thus leaving both hands free, that facilitates measurements. The instrument can be fastened to a waist belt, hung on the neck or installed on any flat surface.

High accuracy of results is ensured even for diagnosis in heavy weather conditions. The MIKO-10 operation is guaranteed at a temperature range from -20 to +55 °C

STANDARD COMPLETE SET

- Instrument MIKO-10 and covering documents
- Belts for the instrument fastening on the wrist
- Short test cable
- Network adapter for battery charging
- USB 2.0 A-B Cable
- Shunt for checking the operability

protective case
is provided upon order

PRECISION MICROOHMMETER MIKO-21

Measurement of transient resistances of electric circuits in the range of 0.1 μΩ ÷ 2 Ω, the lowest error being ±0.05%

Measurements using the rated current up to 200A. Current runs continuously and for a sufficient period of time

There are four methods programmed in the instrument for resistance measurement start-up

SPECIFICATIONS

SPECIFICATIONS	VALUE
Range of resistance measurements, Ohm	0.1 μΩ ÷ 2 Ω
Range of test current amperage, A	1 ÷ 200
Error of measurements, %	±0.05%
Time of measurement:	
in Mode 1, sec	not more than 2.0
in Mode 2 on a bulk-oil circuit breaker with battery charge saving	10 ÷ 30
in Mode 3 on a bulk-oil circuit breaker, sec	5 ÷ 15
Period of continuous operation (in normal conditions), hrs, no less than	8
Number of tests (in normal conditions), no less than Energy independent memory, pcs, not more than	500 1000
Display of the instrument	Sensor, color, graphic, 480x272 dots
Types of data transfer channels	USB/USB Flash
Consumed power does not exceed, V	60
Operating temperature range, °C	-20 ÷ +50
Test block weight, kg (lbs)	3.3 (7.28)
Dimensions, mm	270x250x130
IP rating in operating state	IP40
IP for transportation	IP67
Warranty	36 months
Interface language / User manuals language	English
Calibration period, year	3

Measurement of transient electric circuits' resistances in the range of 0.1 μΩ ÷ 2 Ω, the lowest error being ±0.05%:

- in high-voltage circuit breaker contacts (including with built-in current transformers);
- in disconnecting switches, separators, and short-circuiters;
- in packaged switchgears;
- in contact couplings and in weld seams, etc.

In microohmmeter MIKO-21 measurement of transient resistances of minimum-oil and bulk-oil circuit breakers is operated using separate automatic modes optimized for those circuit breakers. Current transformers of bulk-oil circuit breakers form a prolonged transition process when the test current is applied. Special algorithms with automatic stop of measurements allow avoidance of subjective mistakes.

There are four methods programmed in the instrument for resistance measurement start-up:

- MODE 1 - "single-shot start-up", i.e., start-up by pressing START button located on the front panel of the instrument.
- MODE 2 - "start-up against circuit closing" - automatic measurement start-up against the test circuit closing.
- MODE 3 - "regular star-up" - measurements are started up in the pre-specified time intervals.
- MODE 4 - "regular circuit"- regular automatic measurement start-up against the test circuit closing.

Amperage in the MIKO-21 can be set in several ways:

- by selecting from a number of specified values: 10A, 50A, 100A, and 200A;
- by setting the automatic mode for selecting the test amperage;
- by manual setting the test current in the range from 1 to 200 A at a step of 1A.

Archive of the instrument contains passports of HV circuit breakers with indication of maximum and/or minimum permissible transient resistances of contacts, and passports for rejected resistors with indication of permissible values of the upper and lower thresholds of resistances facilitates automatic detection, and the device beeps if the results of measurements go beyond the permissible limits.

The Instrument can be manipulated either from the film keyboard or from the sensor display, as suits. Communication with PC via USB or a flash card facilitates data transfer from the Instrument to the Company's data base.

Light weight (3.3 kg), non-volatile memory (up to 1000 measurements) and availability of "automatic measurements saving" mode reduces the diagnostics time.

Suitable test cable or a set of test cables of ergonomic design can be selected from a large range of additional accessories.

STANDARD COMPLETE SET:

- Instrument MIKO-21 and covering documents
- Set test cables #2
- Main cable
- Earth wire
- Shunt for checking the operability
- Safety devices VP2B-1V-21
- Bag for transportation of cables, documentation and other accessories

UNIVERSAL MICROMILLIKILOOHMMETER MIKO-2.3

Operates in 4 modes: microohmmeter, milliohmmeter, kiloohmmeter and thermometer

MIKO-2.3 with its weight of only 2.7 kg produces current of 1,000A

Light-weight and self-contained supply (charge time is 5 min) ensure independence and mobility

SPECIFICATIONS

SPECIFICATIONS	VALUE
"microohmeter" mode:	
Electric resistance measuring range, μOhm	$1 \div 10^5$
Intrinsic relative error of electric resistance measurement, %	±0.2
Range of test current amperage in "CT (current transformer)-available" and "CT-not available" submodes, A	10 ÷ 1,000*
Range of test current amperage in "CT-available Tmax" submode, A	100 ÷ 400
"milliohmmeter" mode:	
Electric resistance measuring range, mOhm	$0.1 \div 10^6$
Intrinsic relative error of electric resistance measurement, %	±0.2
Range of test current amperage, A	0.5 ÷ 5
"kiloohmmeter" mode	
Electric resistance measuring mode, kOhm	$0.1 \div 3*10^2$
Intrinsic relative error of electric resistance measurement, %	±0,5
Value of induced voltage across the resistor, kV	≤5
"thermometr" mode	
Temperature measuring range, °C	-20 ÷ +120
Intrinsic absolute error of temperature measurement, °C	±1.0
Maximum accumulator charge time, min	5
Operation temperature range, °C	-20 ÷ +40
Maximum measuring unit weight, kg	2.7
Dimensions, mm	150x190x75
IP rating in operating state and for transportation	IP20
Warranty	13 months
Interface language /User manuals language	English
Calibration period, year	1

*Maximum current depends on the measuring cable

All types of electrical equipment (transformers, electrical machines and electrical switching devices) require different means for full-rate diagnostics. However in case of direct-current resistance measurement the multipurpose instrument MIKO-2.3 can be used.

μΩ 1000A

This mode is designed for measuring transfer resistances of any switching devices as well as of demountable and nondemountable contact connections in the range within 1 μOhm ÷ 10^5 μOhm. Moreover, this mode allows considering the availability or absence of current in the measured circuit of transformer.

When measuring transfer resistances of contacts and connections questions regarding the strength of the measuring current arise as in case of dry contacts the result of measurement will be falsely high. That is why the main requirements to microohmeters are: provision of quite heavy operating current which is able to burn acidified films that appear on contacts and give significant error at resistance measuring.

mΩ

It is designed for direct-current resistance measurement in circuits with high inductance (transformers, electromagnets etc.) within the range of 0.1 mOhm ÷ 10^6 mOhm. Two submodes are used here: measurement of one-phase and three-phase windings.

kΩ

It is designed for resistance measurement of potential dividers, ballast, closing and other resistors in terms of considerable interference and induced voltage within the range of 0.1 kOhm ÷ $3*10^2$ kOhm.

t^0

It is designed to measure temperatures of windings, oil and air within the range of -20°C to +120°C.

AUTO

Switching on each of four modes occurs automatically when appropriate input cable (from the instrument set is connected).

Versatility and weight of the appliance are especially critical for organizations responsible for facility commissioning that have to constantly carry heavy weights of instruments and equipment for significant distances.

MIKO-2.3 input cables are equipped with clamps of "alligator clip with ground clamp" type of unique design that has no analogues by other manufacturers of instruments. This design ensures quick and faultless connection to an object that excludes errors of measurement of small resistance values, and ensures reliable contact even in case of oxygenated surfaces of an object.

STANDARD COMPLETE SET:

- The instrument MIKO-2.3 and accompanying documents
- K162 microohmmeter cable
- Potential spring-loaded contact
- Potential pin contact
- K233 milliohmmeter cable
- K322 kiloohmmeter cable
- Thermometer with K411 cable
- Mains extension cable
- RS-232 interface cable
- ZU-1A charging device
- Shunt for checking the operability
- Zero resistance equivalent
- Support
- Instrument transportation bag
- Bag for transportation of cables, documentation and other accessories

MICROMILLIKILOOHMMETER MIKO-2.3 FIELD OF APPLICATION

Measured circuit	Measuring mode MIKO-2.3	Measuring range MIKO-2.3	Standard resistance range of measured circuit
HIGH-VOLTAGE CIRCUIT BREAKERS (OIL, MAGNETIC, AIR, SULFUR-HEXAFLUORIDE AND VACUUM)			
Resistance of high-voltage circuit breakers main contacts	microohmmeter	from 1 to 10^5 μOhm	from 8 to 2000 μOhm
Resistance of winding of switching on/off electromagnet	milliohmmeter	from 0.1 to 1000 Ohm	from 1 mOhm to 100 Ohm
Resistance of drive spring engines winding	milliohmmeter		from 0.5 to 100 Ohm
Resistance of preswitched on resistors	kiloohmmeter	from 0.1 to 300 kOhm	from 100 to 1000 Ohm
Resistance of air circuit breakers engines (Ohmmeter)	kiloohmmeter		from 100 Ohm to 15 kOhm
Resistance of MKP-110 type circuit breakers compensating resistors	kiloohmmeter		from 750 to 1000 Ohm
LOAD-BREAK SWITCHES (MAGNETIC, SULFUR-HEXAFLUORIDE AND VACUUM)			
Resistance of circuit breaker main contacts	microohmmeter	from 1 to 10^5 μOhm	from 8 to 2000 μOhm
Resistance of winding of switching on/off electromagnets	milliohmmeter	from 0.1 to 1000 Ohm	from 1 mOhm to 100 Ohm
Resistance of drive spring engines winding	milliohmmeter		from 0.5 to 100 Ohm
DISCONNECTING, ISOLATING AND SHORT-CIRCUITING SWITCHES			
Resistance of main contacts	microohmmeter	from 1 to 10^5 μOhm	from 8 to 2000 μOhm
Resistance of drive spring engines winding	milliohmmeter	from 0.1 to 1000 Ohm	from 1 mOhm to 100 Ohm
META-CLAD SWITCHGEARS OF INTERNAL AND EXTERNAL INSTALLATIONS			
Resistance of main contacts	microohmmeter	from 1 to 10^5 μOhm	from 8 to 2000 μOhm
	milliohmmeter	from 0.1 to 1000 Ohm	
Resistance of winding of switching on/off electromagnets	milliohmmeter	from 0.1 to 1000 Ohm	from 1 mOhm to 100 Ohm
Resistance of drive spring engines winding	milliohmmeter		from 0.5 to 100 Ohm
POWER TRANSFORMERS, AUTOTRANSFORMER AND OIL-IMMERSED REACTORS			
Measuring of transformer winding direct-current resistance	milliohmmeter	from 0.1 to 1000 Ohm	from 0.5 mOhm to 10 Ohm
VOLTAGE TRANSFORMERS (ELECTROMAGNETIC AND CAPACITIVE)			
Measuring of winding direct-current resistance	milliohmmeter	from 0.1 to 1000 Ohm	from 0.05 to 500 mOhm
	kiloohmmeter	from 0.1 to 300 kOhm	from 100 Ohm to 100 kOhm
CURRENT TRANSFORMERS			
Resistance of current and voltage transformer secondary	milliohmmeter	from 0.1 to 1000 Ohm	from 0.05 to 500 mOhm

COLLECTING AND CONNECTING BUS-BARS

Testing of cable and bus connections	microohmmeter	from 1 to 10^5 µOhm	from 1 to 100 µOhm

POWER CABLE LINES

Cable lines monitoring	milliohmmeter	from 0.1 to 1000 Ohm	from 1 mOhm to 100 Ohm

CUT-OUTS AND FUSE-DISCONNECTORS FOR THE VOLTAGE OF MORE THAN 1kV

Direct-current resistance of fuse-disconnector cartridge conducting part measurement	milliohmmeter	from 0.1 to 1000 Ohm	from 0.1 to 10 mOhm

CONTACT CONNECTION OF WIRES, PROTECTIVE EARTH WIRES, COLLECTING AND CONNECTING BUS-BARS

Transient resistance measurement	microohmmeter	from 1 to 10^5 µOhm	from 1 to 100 µOhm

ELECTRIC EQUIPMENT OF EXCITATION SYSTEMS OF GENERATORS AND SYNCHRONOUS COMPENSATORS

Direct-current resistance of transfer winding and electrical machines in excitation systems measurement	milliohmmeter	from 0.1 to 1000 Ohm	from 0.5 mOhm to 10 Ohm

ELECTRIC INSTALLATIONS OF BUILDINGS AND STRUCTURES (AUTOMATIC CIRCUIT BREAKERS)

Contact testing	microohmmeter	from 1 to 10^5 µOhm	from 1 to 100 µOhm

WAGONS, RAILS

Rail resistance monitoring	microohmmeter	from 1 to 10^5 µOhm	from 100 µOhm to 100 Ohm
	milliohmmeter	from 0.1 to 1000 Ohm	
Wagon wheel pairs resistance monitoring	milliohmmeter	from 0.1 to 1000 Ohm	from 1 to 100 mOhm

NEW VERSION
MILLIOHMMETERS
MIKO-7M(A)

DC current resistance measurement in inductive and noninductive circuits in the range from 10 μOhm ÷ 2 kOhm

Measuring current intensity from 0.005 to 10 A Current runs continuously and for a sufficient period of time

Specific modes for measuring different objects

SPECIFICATIONS

SPECIFICATIONS	VALUE
Resistance range, Ohm	10 μOhm ÷ 2 kOhm
Maximum permissible intrinsic error of resistance measurement	± (0.1% + 0.5 μOhm)
Measuring current intensity, A	0.005 ÷ 10
Relative drift of measuring current intensity, %/s	± 0.002
Maximum consumed power, W	120
Maximum output capacity, W	60
Mains voltage: AC (valid value)	90 ÷ 253V
Mains voltage: DC	127 ÷ 354V
Type of data transmission channel	USB, Bluetooth
Period of charging a completely discharged battery (МИКО-7МА)	8 hrs
Operation temperature range, °C	-20 ÷ +55
Maximum measuring unit weight with battery (МІКО-7МА), kg	4.0
Maximum measuring unit weight without the battery (МІКО-7М), kg	2.7
Dimensions, mm	270x250x130
IP rating in operating state	IP40
IP for transportation	IP67
Warranty	36 months
Interface language / User manuals language	English
Calibration interval, year	3

DC current resistance measurement in inductive and noninductive circuits in the range from 10 μOhm ÷ 2 kOhm, for example windings of power transformers, electromagnets and electric motors, etc. Measuring current intensity from 0.005 to 10 A.

The device integrates special-purpose modes for measuring different objects with account of their specific features: resistive and inductance objects; voltage transformers; current and power transformers.

High precision of measurements both in laboratory environment and at substations under industrial noises is achieved owing to calculation and setting (for any resistance) of specific maximum possible test current limited by effective power of the device only. Therefore, ratio between a valid signal to winding resistance and the noise amplitude remains high at any resistance.

High level of protection and safety conformance in regard to:

- measuring current exceeding;
- self-induction electromotive force(emf);
- a set of required protective means against superheat of the measuring unit;
- protection grounding contact in plug and safety earthing terminal on the block of the measuring unit.

History of measurements stored in the instrument is available for viewing, copying and deleting. The history is stored in the non-volatile memory of the instrument (up to 100 cell measu- rements).

Personal computer connection through USB and Bluetooth allows:

- control the instrument by PC;
- systemize and store the results in computer;
- draw up measurement reports.

Data transmission and measurement results filing in are performed in a special program developed by the manufacturer.

Cables of different length and alligator type clamps grip allow to performance ground measurement and the measurement from the cover of transformers of all voltage types.

The instrument powers from the mains and/or integrated storage battery.

For customer's choice the MIKO-7M milliohmmeter has two modifications: with an in-built battery (MIKO-7MA) and without an in-built battery (MIKO-7M). The device can also be powered from the mains (≃ 110÷220, 330V).

STANDARD COMPLETE SET:

- Instrument MIKO-7M (MIKO-7MA) and accompanying documents
- Mains cable
- Ground wire
- Shunt for checking the operability
- VP2B-1V-2A cut-out
- Zero resistance equivalent
- Attachment devices set kit

DURING ORDER SELECT AT LEAST ONE MEASURING CABLE FROM ADDITIONAL ACCESSORIES

- A set of cables (8.5m, 80mm 'crocodile' jaws)
- A set of cables (8.5m, 103mm jaws of a G-clamp)
- Cable with current and potential contacts
- Cable for CT and VT (4.0m, 25mm 'crocodile' jaws)

NEW VERSION
MILLIOHMMETER
MIKO-8M(A)

DC current resistance measurement in inductive and noninductive circuits in the range from 10 μOhm ÷ 10 kOhm

Measuring current intensity from 0.005 to 10 A Current runs continuously and for a sufficient period of time

OLTC in-place check mode (DRM-test) is an additional function

SPECIFICATIONS

SPECIFICATIONS	VALUE
Resistance range, Ohm	10 μOhm ÷ 10 kOhm
Maximum permissible intrinsic error of resistance measurement	± (0.1% + 0.5 μOhm)
Measuring current intensity, A	0.005 ÷ 10
Relative drift of measuring current intensity, %/s	± 0.002
Maximum consumed power, W	120
Maximum output capacity, W	60
Mains voltage: AC (valid value)	90 ÷ 253V
Mains voltage: DC	127 ÷ 354V
Type of data transmission channel	USB, Bluetooth
Period of charging a completely discharged battery (МИКО-8МА)	8 hrs
Operation temperature range, °C	-20 ÷ +55
Maximum measuring unit weight with battery (MIKO-8MA), kg	4.0
Maximum measuring unit weight without the battery (MIKO-8M), kg	2.7
Dimensions, mm	270x250x130
IP rating in operating state	IP40
IP for transportation	IP67
Warranty	36 months
Interface language / User manuals language	English
Calibration interval, year	3

The instrument is designed for DC current resistance measurement in inductive and no inductive circuits in the range from 10 μOhm ÷ 10 kOhm, for example in windings of power transformers, electromagnets and electric motors, etc. Measuring current intensity from 0.005 to 10 A.

The device integrates special-purpose modes for measuring different objects with account of their specific features: resistive and inductance objects; voltage transformers; current and power transformers; generators, motors, compensators, connection filters, and magnets.

High accuracy of measurements both in laboratory environment and at substations under industrial noises is achieved owing to calculation and setting (for any resistance) of specific maximum possible test current limited by effective power of the device only. Therefore, ratio between a valid signal to winding resistance and the noise amplitude remains high at any resistance.

OLTC "in-place" check mode allows carrying out of in-place check and diagnostics of OLTC with current-limiting resistors without removing the contactor tank covers. The instrument outputs an assessment oscillogram. Measurements in milliohmeter mode and in in-place check mode complement each other and provide a comprehensive picture of the transformer state.

The archive of measurements available in the device allows review, copy or delete test's results stored in the self-powered memory of the device (up to 1000 measurements), as well as for supporting the following computations:

- Automatic calculation of relative deviation of winding resistance at three phases against each other;
- Automatic recalculation of linear resistance of windings, connected with delta or star connection to the phase winding resistance;
- Automatic recalculation of resistance at current temperature to the resistance at certified temperature (with due regard to winding material);
- Automatic calculation of deviations measured and normalized to the certified temperature of winding resistance in relation to the certified values of resistances;
- Automatic calculation of winding temperature based on its measured and certified value of resistance and certified temperature.

Color graphic display of high brightness ensures easy reading on a sunny day, whereas intuitively understandable interface with a sensor display facilitates the instrument use. Personal computer connects by USB and Bluetooth.

Cables of different length and the grip of alligator type clamps allowing performance of ground measurement as well as the measurement from the cover of transformers of all voltage types.

Power from the mains and/or integrated storage battery: For customer's choice the MIKO-8M milliohmmeter has two modifications with an in-built battery (MIKO-8MA) and without an in-built battery (MIKO-8M). The device can also be powered from the mains (≃ 110÷220, 330V).

STANDARD COMPLETE SET:

- Instrument MIKO-8M (MIKO-8MA) and accompanying documents
- Cable USB 2.0 A-B
- Mains cable
- Ground wire
- Shunt for checking the operability
- VP2B-1V-2A cut-out
- Zero resistance equivalent
- Attachment devices set kit

DURING ORDER SELECT AT LEAST ONE MEASURING CABLE FROM ADDITIONAL ACCESSORIES

- A set of cables (8.5m, 80mm 'crocodile' jaws)
- A set of cables (8.5m, 103mm jaws of a G-clamp)
- Cable with current and potential contacts
- Cable for CT and VT (4.0m, 25mm 'crocodile' jaws)

MODERN MILLIOHMMETER MIKO-9(A)

DC current resistance measurement in inductive and noninductive circuits in the range from 10 μOhm ÷ 30 kOhm

Measuring current intensity from 0.005 to 10 A Current runs continuously and for a sufficient period of time

In-built battery

Additional functions: demagnetizing mode; DRM-test of LTC devices; heat test

SPECIFICATIONS

SPECIFICATIONS	VALUE
Resistance range, Ohm	10 μOhm ÷ 30 kOhm
Maximum permissible intrinsic error of resistance measurement	± (0.1% + 0.5 μOhm)
Measuring current intensity, A	0.005 ÷ 10
Relative drift of measuring current intensity, %/s	± 0.002
Maximum consumed power, W	120
Maximum output capacity, W	60
Mains voltage: AC (valid value)	90 ÷ 253V
Mains voltage: DC	127 ÷ 354V
Type of data transmission channel	USB, Bluetooth, RS-485
Period of charging a completely discharged battery (MIKO-9A)	8 hrs
Operation temperature range, °C	-20 ÷ +55
Maximum measuring unit weight (MIKO-9A), kg	4.0
Dimensions, mm	270x250x130
IP rating in operating state	IP40
IP for transportation	IP67
Warranty	36 months
Interface language	English
User manuals language	English
Calibration interval, year	3

The instrument is designed for DC current resistance measurement in inductive and no inductive circuits in the range from 10 μOhm ÷ 30 kOhm, for example windings of power transformers, electromagnets and electric motors, etc. Measuring current intensity from 0.00075 to 10 A.

The instrument's peculiarity is the ability to connect to three phases of a transformer and measurements with automatic switch-over. Measurements are automatically stored in the non-volatile memory.

Transformer's magnetic circuit magnetization guarantees fast and accurate measurement of DC electric resistance of power transformers, particularly, by triangular-form connection of the secondary winding, if conventional methods do not produce a reliable result.

Demagnetization mode of power transformer's core follows requirements of GOST 3484.1 and is operated either fully automatically or manually by specifying the demagnetization current increment and limit.

OLTC "in-place" check mode allows carrying out of in-place check and diagnostics of OLTC with current-limiting resistors without removing the contactor tank covers. The instrument outputs an assessment oscillogram. For operating this mode the instrument shall be ordered with one of the two types of short-circuiting cables.

The instrument has a special 'heat test' mode (cooling test). The testing procedure and results interpretation technique follow the requirements set forth in Item 2 of GOST 3484.2-88 "Power Transformers. Heat Tests".

The archive of measurements available in the device allows review, copy or delete test's results stored in the self-powered memory of the device (up to 1000 measurements), as well as for supporting the following computations:

- Automatic calculation of relative deviation of winding resistance at three phases against each other;
- Automatic recalculation of linear resistance of windings, connected with delta or star connection to the phase winding resistance;
- Automatic recalculation of resistance at current temperature to the resistance at certified temperature (with due regard to winding material);
- Automatic calculation of deviations measured and normalized to the certified temperature of winding resistance in relation to the certified values of resistances;
- Automatic calculation of winding temperature based on its measured and certified value of resistance and certified temperature.

Color graphic display of high brightness ensures easy reading on a sunny day, whereas intuitively understandable interface with a sensor display facilitates the instrument use.Personal computer connects by USB or Bluetooth.

STANDARD COMPLETE SET:

- Instrument MIKO-9 and accompanying documents
- Cable USB 2.0 A-B
- Mains cable
- Ground wire
- Shunt for checking the operability
- VP2B-1V-2A cut-out
- Zero resistance equivalent
- Attachment devices set kit

DURING ORDER SELECT AT LEAST ONE MEASURING CABLE FROM ADDITIONAL ACCESSORIES

- A set of cables (8.5m, 80mm 'crocodile' jaws)
- A set of cables (8.5m, 103mm jaws of a G-clamp)
- Cable with current and potential contacts
- Cable for CT and VT (4.0m, 25mm 'crocodile' jaws)

COMPARISON OF MILLIOHMMETERS FOR RESISTANCE MEASUREMENT GROUP MIKO

	MIKO-9	MIKO-8M	MIKO-7M
			

SCOPE OF APPLICATION

Windings of power transformers	✓	✓	✓
In-place checking of transformer OLTCs	✓	✓	⛔
Windings of instrument current and voltage transformers	✓ at winding resistance of up to 30 kOhm	✓ at winding resistance of up to 10 kOhm	✓ at winding resistance of up to 2 kOhm
Windings of electromagnets, electric motors and compensators	✓	✓	✓
High-frequency filter windings	✓	✓	✓
Compensatory, current-limiting and other resistors of high-voltage circuit breakers	✓	✓	✓
Contacts and contact connections of power and signal circuits	✓	✓	✓
Cables	✓	✓	✓

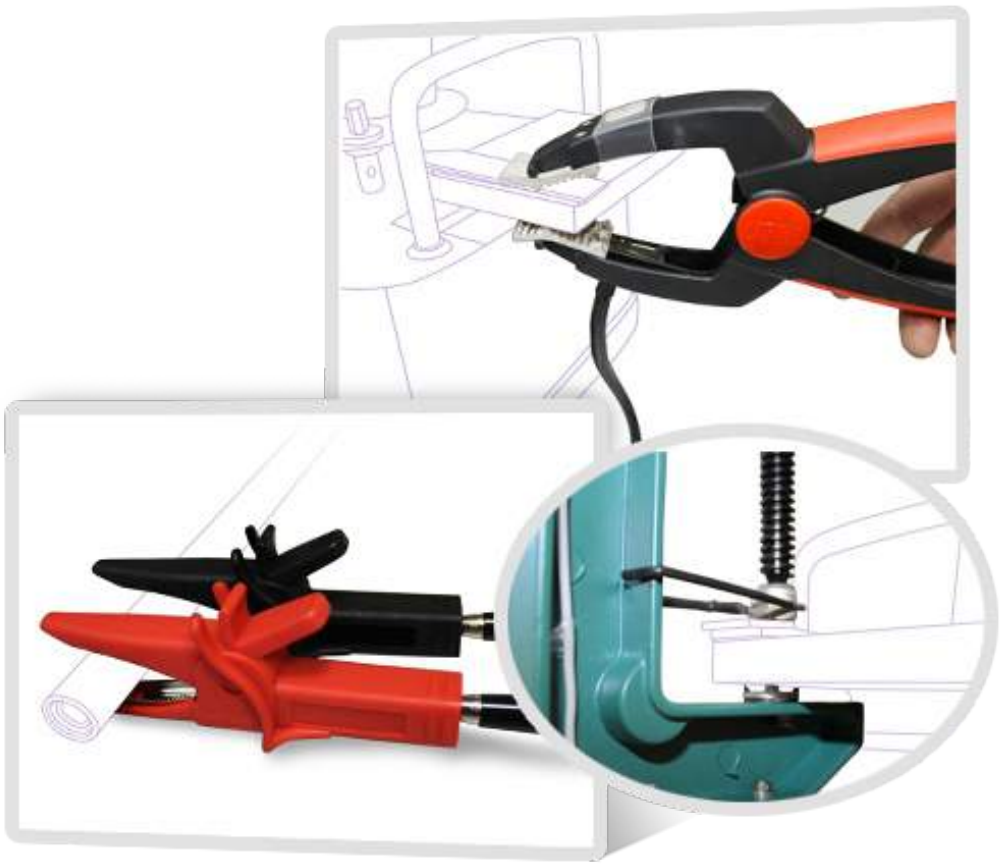
CHARACTERISTICS

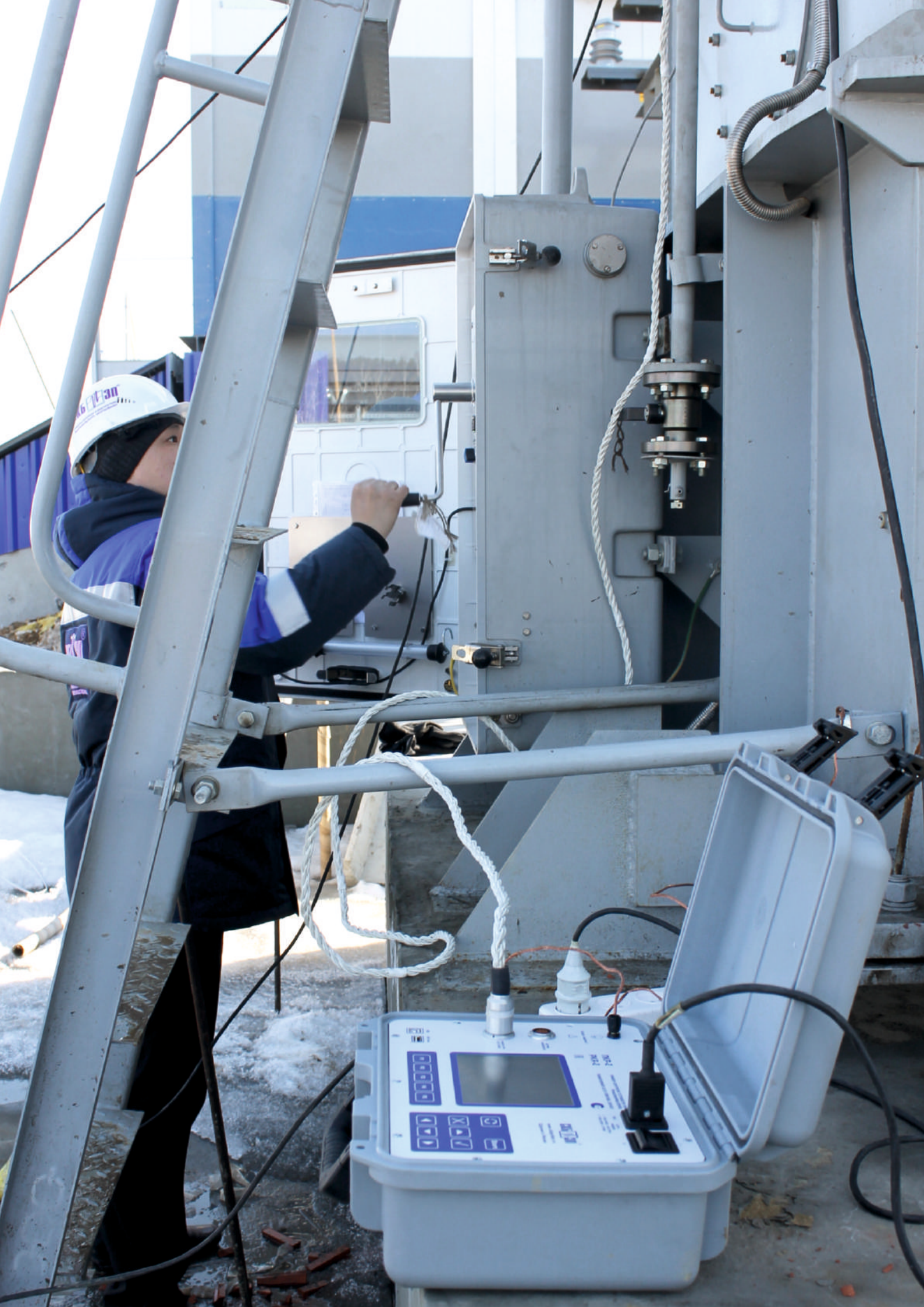
Measuring range	10 µOhm - 30 kOhm	10 µOhm - 10 kOhm	10 µOhm - 2 kOhm
Current rate range	0.005 - 10A	0.005 - 10A	0.005 - 10A
Insignificant error	±0.1%	±0.1%	±0.1%
Protection from: - electromotive force (emf) of self-induction; - exceeding of measuring current; - superheat.	✓	✓	✓
Non-volatile memory	up to 1000 measurements	up to 1000 measurements	up to 100 measurements
Display	sensor, color, graphical TFT display (5")	sensor, color, graphical TFT display (5")	monochrome graphic display 128x64
Instrument control	directly and via computer using USB-cable or RS485-cable	directly and via computer using USB-cable	directly and via computer using USB-cable
Type of data transmission channel	USB, Bluetooth, RS-485	USB, Bluetooth	USB, Bluetooth
Power supply	✓	✓	✓
Power supply an in-built battery	✓ on request, modification MIKO-9A	✓ on request, modification MIKO-8MA	✓ on request, modification MIKO-7MA
Case	composite case	composite case	composite case
Dimensions, mm	270x250x130	270x250x130	270x250x130
Weight with battery, kg	4.0	4.0	4.0
Weight without battery, kg	-	2.7	2.7

FUNCTIONALITY

Special-purpose modes for measuring different objects with account of their specific features	✓ 10 objects	✓ 10 objects	✓ 5 objects
Automatic or manual setting of measuring current	✓	✓	✓
Special mode of measurements in the inductance-free circuits (three methods of measurements start-up)	✓	✓	✓
Ability to connect to three phases of a transformer and to perform measurements at automatic switch-over	✓	⛔	⛔
There is also a mode for resistance measurement across two windings simultaneously	✓	⛔	⛔

Automatic accounting of load inductance. Instrument automatically defines moment of resistance establishment and stops measurement	✓	✓	✓
Automatic inductance category after measuring	✓	✓	✓
Specialized mode of electric resistance measuring of winding of power transformers with OLTC. Instrument may not be switched off when switching OLTC	✓	✓	✓
"Heat test" mode (cooling test). The testing procedure follows the requirements set forth in Item 2 of GOST 3484.2-88 "Power Transformers. Heat Tests"	✓	–	–
Demagnetization mode of transformer's magnetic circuit	✓	–	–
Automatic calculation of relative deviation of winding electric resistance of three phases from each other	✓	✓	–
Automatic conversion of linear electrical resistance of windings connected in a delta or star circuit to the electrical resistance of the phase windings	✓	✓	–
Automatic conversion of electrical resistance of windings, measured at current temperature to electric resistance at certified temperature	✓ taking into account winding material	✓ taking into account winding material	–
Automatic calculation of the deviations measured and reduced to certified temperature of electrical resistance of windings with respect to certified resistance values	✓	✓	–
Automatic calculation of winding temperature according to its measured and certified value of electrical resistance and certified temperature	✓	✓	–
In-place checking and express diagnostics of OLTC condition at any weather conditions without removing the contactor tank cover	✓	✓	–
Construction of assessment diagram of OLTC switching directly on the instrument	✓	✓	–
Defining of OLTC fault nature: for instance, identifying of interruption of current-limiting resistors, poor selector contacts, etc.	✓	✓	–





PKR GROUP: INSTRUMENTS FOR DIAGNOSTICS OF ON-LOAD TAP CHANGERS OF POWER TRANSFORMERS

Instruments for diagnostics of reactor and resistor devices of power transformer OLTC.

PKR-2

According to statistics of one of the leading engineering companies in the energy industry ORGRES, failures of 35-750kV transformers due to OLTCs make 13.5%. According to data of MRSK Sibir Branch of Krasnoyarskenergo, more than 23% of 35kV transformer failures are due to OTC devices. Causes of OLTC faults include failures in operation of contactors and switches, burns on the contactor devices contacts, seizure of contactor mechanisms, deterioration of mechanical strength of steel details, and others.

The SKB EP Company offers analyzers of the PKR group (PKR-2 and PKR-2M) for revealing the causes of OLTC failures and for automatic diagnostics. The instruments are designed for generating the oscillograms of contactors operation, for taking the circular diagrams on three phases simultaneously.

PKR-2M

One of the PKR-2M benefits is an option of non-destructive diagnosis of high-speed OLTC devices using the DRM-test, without removing the contactor tank cover. The instrument has sophisticated hardware for implementing the DRM method, and owing to mathematical processing the oscillogram generated is rather close to the results that can be obtained by direct connection to contactor's contacts. Non-destructive testing of OLTC devices is not labor-intensive, therefore, it should be performed at any scheduled or non-scheduled check of a power transformer.

The use of PKR-2 and PKR-2M instruments considerably reduces expenses and labor costs of a company, enhances the transformer diagnosis quality helping to avoid unnecessary repair.

CERTIFICATES

- Safety Test Certificate IEC 61010-1:2001
- EMC Compatibility IEC 61326-1:2005
- Russian Register of Innovative Products
- Recommended for use in JSC Russian Railways electric installations
- PJSC ROSSETI Register of Innovative Solutions
- Russian State Register Certificates
- Declaration of Conformity of the Customs Union

INSTRUMENTS FOR DIAGNOSTICS OF OLTC POWER TRANSFORMERS
PKR-2 AND PKR-2M

The instrument is represented in two modifications: PKR-2 и PKR-2M

The instruments are intended for destructive and non-destructive (DRM-test) check of condition of the types (both resistor and reactor) of the transformer OLTC

They allow taking the circular diagrams and oscillograms

SPECIFICATIONS

SPECIFICATIONS	VALUE	
	PKR-2	PKR-2M
Time interval measuring range, sec	0.01 ÷ 1200	
Maximum permissible intrinsic absolute error of time interval measurement, sec	$\pm(3+t_x)*10^{-4}$	
Time interval measurement resolution ability, ms	±0.1	
Angular movement measuring range, degrees	2 ÷ 360	
Intrinsic absolute error of angular movement measurement, degrees	±0.56	
Direct current intensity measuring range, A	1 ÷ 4	
Direct current electric voltage measuring range, V	1 ÷ 20	
Direct current electric voltage measurement range, Ohm	1 ÷ 20	
Resistance measurement sampling rate per channel, kHz	10 ± 0.1	
OLTC check mode	demountable	demountable and in-place (DRM method)
Inbuilt battery supply	none	available
Time of inbuilt battery operation in mixed mode (operation/standby), h	—	2 ÷ 16
Number of computer communication channels, pcs.	2 (USB, USB host)	
Maximum consumed power , W:		
- in start standby mode	15	
- in measurement mode	210	
Operation temperature range, °C	-20 ÷ +50	
Maximum measuring unit weight, kg	5.1	6.1
Dimensions, mm	360x290x165	
IP rating in operating state	IP20	
IP for transportation	IP64	
Warranty	36 months	
Interface language / User manuals language	English	
Calibration period, year	3	

The instrument is represented in two modifications:

	PKR-2	PKR-2M
OLTC check mode	demountable	demountable and in-place (DRM method)
Inbuilt battery supply	none	available

OLTC in-place check enables to conduct express diagnostics of the OLTC technical condition without opening the tank or OLTC removing. This mode is based on the **DRM method** and consists in the amperage measurement via the winding with integrated OLTC device. This check enables to obtain the contactor switchover diagrams for a wide range of switching devices, except reactor type ones.

The application of in-place check mode based on the DRM method doesn't require:

- Opening of the tank or hatch of the fault-free/faulty OLTC and oil drain;
- Additional money and labor costs for the OLTC diagnostics;
- Neither connection of additional elements nor knowledge of current-limiting resistors of the checked on-load tap changer, since all fine adjustments to a certain OLTC are conducted automatically in the instrument.

The instrument is completed with a special transducer for the radial diagram measurement. Its interface with shafts of different drives is provided with a set of axes and bushings, which are installed without any tools by simply putting on the shaft extension.

Resistor type OLTC contactor switchover oscillography enables to detect the actuation delay, non-simultaneity of in phase actuation and bouncing during switchover.

Oscillography and Radial diagram measurement are done simultaneously based on three phases. No additional elements (for example, resistors) or knowledge of resistances of current-limiting resistors of the checked on-load tap changer are required to measure the OLTC parameters. All adjustments to a specific OLTC are performed automatically in the instrument.

OLTC check in static mode. Check is conducted during the drive shaft slow rotation using a handle simultaneous display of contact closures/openings in degrees and voltage and current values.

The measurement results are stored in the non-volatile memory of the instrument, on the external flesh memory, and may be transferred to the computer. The instrument is equipped with a large color high-brightness and high-contrast display facilitating the graph processing to present information in graphical or tabular form.

The instrument is completed with special long calipers to be conveniently connected to some OLTCs, in this case, it is not necessary to drain oil from the contactor tank.

STANDARD COMPLETE SET:

- Instrument PKR-2 / PKR-2M and accompanying documents
- Angular movement transducer DP22
- Ground clamp
- Handle for the OLTC shaft rotation
- Axis No. 10 together with a bushing
- Measuring cable completed with a connector
- A short-circuit cable (PKR-2M)
- Mains cable
- Ground wire
- VP2B-1V-2A cut-out
- Cable and ancillary equipment carrying case

ADDITIONAL EQUIPMENT

MANIPULATING ROD

It is aimed for more convenient connecting of measuring cable clips to inputs of the high-voltage equipment from 35 to 220 kV with height up to 5 m from the ground without using ladders and elevators

To be used only on switched off high-voltage electrical equipment

Represented in three sizes up to at the user's choice

SPECIFICATIONS

SPECIFICATIONS	VALUE
Insulating rod	
The rod's length is up to the user's choice, m	2.2
	3.7
	5.1
Extension cable	
Length of the extension cable, m	3.3
Number of cable wires, pc	2
Width of the contact area, mm	25
Clamp jaw size, mm	70
Minimum thickness of the plate to be clamped by crocodile clip, mm	5
The angle of rotation of the crocodile type clamp in the horizontal plane, degrees	±90
The angle of inclination of the crocodile type clamp in the vertical plane, degree	0, 45, 90
Grounding wire	
Cable length, m, not shorter than	3.0
Crocodile clamp jaw size, mm not shorter than	15
Ground clamp jaw, mm, not smaller than	20
Weight of manipulating rod at the working condition (length 2.2 mm), kg	3.4
Weight of manipulating rod at the working condition (length 3.7 mm), kg	4.0
Weight of manipulating rod at the working condition (length 5.1 mm), kg	4.6
Operation temperature range, °C	-15 ÷ +40
Warranty	6 months from the date of shipment

Manipulating rod is aimed for more convenient connecting of measuring cable clips to inputs of the high-voltage equipment from 35 to 220 kV with height up to 5 m from the ground without using ladders and elevators in order to measure its technical characteristics.

Full lengh of the road, m	Nominal voltage of electrical installation, kV
2.2	35
3.7	110
5.1	up to 220

Together with the instruments for circuit breakers control PKV/U3 and PKV/M17 we recommend to purchase manipulating rod aimed for cabels' poles connection from the ground or a tank cover without using ladders or levators.

Manipulating rod is recommended to be used together with micro ohmmeters and milli ohmmeter MIKO-1, MIKO-21 and MIKO-2.3 for measuring cables connection from the ground or a tank cover to circuit breakers conductors and to other elements of HV disconnecting and grounding elements without using ladders or elevators.

If specialists use or plan to use mille ohmmeters MIKO-7M, MIKO-8M or MIKO-9, manipulating rod shall be essential accessory for measuring cables connection from powertransformer tank up to 220 kV to HV winding elements without using ladders or elevators.

When working with OLTC control instruments of power transformers PKR-2 and PKR-2M specialists may use manipulating rod for connecting measuring cables to power transformer tank cover up to 220 kV without using ladders or elevators.

Electrical personnel, certified not lower than the III group of electrical safety, having not lower than secondary education in the field of electrical engineering is allowed to work with the product. Use of manipulating rod is only allowed on switched off high voltage electric equipment.

Maintenance means periodic inspection of the product on a subject of elements damage. The damaged insulating rod (chips, cracks) should be replaced. The rest of the elements (depending on the damage) can be repaired on site.

Manipulating rod is recommended to be stored and operated at a temperature range from -15 to + 40°C in the absence of impurities in the air, causing corrosion. Transportation of the instrument during operation to the place of work and back is allowed in the case for the rod, as well as a bag for the rest of the elements.

STANDARD COMPLETE SET:

- Manipulating rod and accompanying documentation
- Extension cable (6 pcs)
- Grounding wire
- Cable and ancillary equipment carrying case

SKB EP®

DIAGNOSTICS INSTRUMENTS FOR HIGH-VOLTAGE EQUIPMENT




SKB EP, LLC provides training, warranted and post-warranted service of the equipment procured:

- free technical consultations;
- maintenance of instruments (repair, calibration, and verification);
- special training of experts in seminars and webinars;
- individual adaptation of instruments to your high-voltage equipment;
- measurement results interpretation and recommendations for repair, etc.

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